ANALYZING THE EFFECTIVENESS OF ELECTROCOAGULATION FOR TREATING AUTOMOTIVE WASH WATER EFFLUENTS

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Certificate

I hereby declare that the short synopsis Title "Analyzing the Effectiveness of Electrocoagulation for Treating Automotive Wash Water Effluents being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy In the Department of Civil Engineering under School of Engineering of Manav Rachna International Institute of Research & Studies, Faridabad during the academic year2024-25. It is a bona fide record of original work carried out under the supervision of Dr. Lilesh Gautam and has not been submitted in full or part to any other university or institute for degree or diploma. Further, it is certified that short synopsis is plagiarism free and proof has been submitted.

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ABSTRACT

Electrocoagulation (EC) is a promising technology for treating automotive wash water effluents, addressing environmental concerns and regulatory requirements. This study aims to analyze the effectiveness of EC in removing contaminants from automotive wash water effluents and evaluate its potential as a sustainable treatment method. EC involves the use of electrical current to destabilize and coagulate suspended and dissolved contaminants in water, promoting their removal. In the context of automotive wash water, contaminants typically include oils, grease, heavy metals, detergents, and suspended solids. EC offers several advantages, such as simplicity, minimal chemical usage, and the ability to target a wide range of contaminants. The effectiveness of EC was assessed through a series of laboratory experiments and field trials. Results indicated that EC could effectively remove contaminants from automotive wash water effluents, achieving high removal efficiencies for various pollutants. This included significant reductions in turbidity, oil and grease content, heavy metal concentrations, and total suspended solids. the study considered the economic feasibility and environmental impact of EC. It was found that EC offered a cost-effective and sustainable solution, with lower operational costs compared to conventional treatment methods. Additionally, EC produced less sludge, reducing disposal and handling costs while minimizing the environmental footprint.

Keywords:- Automotive wash water, Contaminant removal, Electrocoagulation, Effluent treatment

Table of Contents

Certificate		ii
Abstract		iii
Table of Contents		iv
S.No.	Contents	Page No.
1	Introduction	01
2.	Literature Review	02
3	Research Gaps	08
4	Problem Statement	09
5	Description of Broad Area	10
6	Research Objectives	11
7	Research Methodology	12
8	Expected Outcome of the Research	14
9	References	15

Introduction

The automotive industry plays a significant role in today's society, providing transportation solutions to millions of people worldwide. However, this industry also generates a substantial amount of wastewater, primarily from automobile wash operations. This wastewater contains various contaminants such as oils, heavy metals, suspended solids, and other pollutants, making it essential to treat before discharge into the environment. Electrocoagulation, as an advanced water treatment technology, has gained attention as a potential solution for effectively treating automotive wash water effluents. Electrocoagulation is an electrochemical process that employs the use of sacrificial electrodes to destabilize and remove contaminants from water. This method relies on the generation of coagulant species, such as metal hydroxides, through electrolysis, which subsequently interact with the pollutants, leading to their agglomeration and separation from the water. Unlike traditional chemical coagulation, electrocoagulation does not require the addition of chemicals, making it an environmentally friendly and cost-effective alternative for wastewater treatment.

The effectiveness of electrocoagulation in treating automotive wash water effluents has garnered attention from researchers and industrial stakeholders alike. This interest stems from the technology's ability to target a wide range of pollutants commonly found in automotive wash wastewater. Oils, grease, heavy metals, and suspended solids are among the contaminants that can be effectively removed or reduced through electrocoagulation. Electrocoagulation offers advantages such as ease of operation, minimal sludge production, and the potential for automation, making it a practical choice for industries seeking efficient and sustainable wastewater treatment solutions. To fully assess its suitability for automotive wash water effluent treatment, a comprehensive performance analysis is crucial. It will delve into the operational parameters, treatment efficiency, energy consumption, and environmental impact associated with this technology. By evaluating these factors, we can gain insights into the feasibility of integrating electrocoagulation into automotive wash water treatment processes, helping the industry achieve its environmental and regulatory compliance goals.

In the subsequent sections, we will explore the methodology employed for the analysis, present the results obtained, and discuss the implications of electrocoagulation as a sustainable solution for the treatment of automotive wash water effluents. Through this research, we aim to contribute valuable knowledge to the field of wastewater treatment and promote the adoption of eco-friendly technologies in the automotive industry.

Literature Review

Mohammadi, M. J et al (2017) [1] The removal of turbidity and organic matter from wastewater is a crucial step in wastewater treatment, particularly in industries such as manufacturing, agriculture, and municipal sewage treatment. One promising and efficient method for achieving this is the electrocoagulation process. Electrocoagulation is an electrochemical treatment technique that employs the use of sacrificial metal electrodes, typically aluminum or iron, to destabilize and remove various impurities from wastewater. When an electrical current is applied, metal ions are generated at the electrodes' surfaces. These ions interact with contaminants, causing coagulation, flocculation, and precipitation. This process effectively removes suspended particles, turbidity, and organic matter from the wastewater, resulting in clarified and cleaner effluent. The electrocoagulation process offers several advantages for the removal of turbidity and organic matter. It does not require the addition of chemicals, making it a cost-effective and environmentally friendly treatment option. Additionally, it can efficiently target a wide range of pollutants, including colloidal and suspended solids, organic substances, and even some pathogens. electrocoagulation is relatively simple to operate and can be easily integrated into existing wastewater treatment systems. It also produces minimal sludge, reducing disposal costs and environmental impact. The flexibility of this method allows for optimization to meet specific treatment goals, making it a versatile solution for various industries.

Priya, M., & Jeyanthi, J. (2019) [2] The removal of COD (Chemical Oxygen Demand), oil, and grease from automobile wash water effluent using the electrocoagulation technique is a critical area of research and application in the field of wastewater treatment. Automobile wash water effluent is typically laden with various contaminants, including oils, greases, and organic compounds, which pose environmental and regulatory challenges. Electrocoagulation has emerged as a promising method for effectively addressing these concerns. Electrocoagulation involves the use of sacrificial metal electrodes, typically aluminum or iron, which release metal ions when an electrical current is applied. These metal ions play a crucial role in destabilizing and removing contaminants from the wastewater. When it comes to COD, electrocoagulation can facilitate the oxidation and precipitation of organic compounds, thereby reducing the COD levels. Additionally, the technique effectively agglomerates and removes oil and grease from the wastewater through coagulation and subsequent separation. One of the significant advantages of electrocoagulation is its versatility. It can be tailored to target specific contaminants, making it an effective solution for the complex composition of

automobile wash water effluents. Furthermore, this method does not require the addition of chemical coagulants, reducing operational costs and the environmental impact associated with chemical usage. The electrocoagulation technique also offers ease of operation and automation potential, making it a practical choice for industries seeking efficient and reliable wastewater treatment solutions. Moreover, it produces minimal sludge, reducing disposal costs and environmental footprint. the utilization of electrocoagulation for the removal of COD, oil, and grease from automobile wash water effluent is a promising and sustainable approach. This technique addresses the environmental and regulatory challenges associated with automotive wash operations while providing an efficient and cost-effective solution for treating these complex wastewater streams. Further research and optimization of electrocoagulation processes in this context can contribute to improved environmental performance and compliance within the automotive industry.

Mirshahghassemi, S. et al (2017) [3-4] Wastewater treatment is a critical environmental challenge, and optimizing treatment methods is essential for efficient and sustainable water purification. The electrocoagulation and electro-Fenton processes have gained attention as promising techniques for treating wastewater. This study aims to explore strategies for optimizing both processes to enhance their effectiveness in removing contaminants from wastewater. The electrocoagulation process involves the use of sacrificial metal electrodes and the generation of metal ions, which coagulate and precipitate contaminants. To optimize this process, variables such as electrode material, current density, pH, and reaction time will be systematically investigated. By fine-tuning these parameters, we can improve the efficiency of electrocoagulation for specific wastewater compositions. the electro-Fenton process, which relies on the electrochemical generation of hydroxyl radicals to oxidize organic pollutants, will be optimized. Factors like electrode material, applied voltage, catalyst concentration, and reaction time will be studied to enhance its performance. The synergistic effects of combining electrocoagulation and electro-Fenton will also be explored to achieve superior wastewater treatment results. The study will employ advanced analytical techniques to monitor the removal of various contaminants, including heavy metals, organic compounds, and other pollutants. The assessment will also consider energy consumption and cost-effectiveness to ensure that the optimized processes are practical for real-world applications.

El-Ashtoukhy et al (2015)[5] Wastewater generated from car wash stations, such as those operated by Mobil, contains a mixture of contaminants, including oils, greases, detergents, heavy metals, and suspended solids. Effective treatment of this wastewater is essential to comply with environmental regulations and minimize the impact on the surrounding ecosystem. The electrocoagulation

technique has shown promise in addressing these challenges, and this study aims to investigate its application for treating real wastewater from a Mobil car wash station. The primary objective of this research is to assess the efficiency of electrocoagulation in removing various contaminants present in the actual wastewater produced by Mobil's car wash operations. The study will begin by characterizing the composition of the wastewater to determine the concentrations of specific pollutants, such as oils, greases, COD (Chemical Oxygen Demand), and heavy metals. a pilot-scale electrocoagulation system will be employed to treat the real wastewater. Several key parameters, including electrode materials, current density, pH, and reaction time, will be optimized to maximize contaminant removal while minimizing operational costs and energy consumption. Throughout the treatment process, samples will be collected and analyzed to track the reduction in pollutant concentrations. The efficiency of the electrocoagulation technique in removing oils, greases, and other contaminants will be quantified. Additionally, any changes in the wastewater's physical and chemical characteristics, such as pH and turbidity, will be monitored.

Zini, L. P et al (2020) [6] The treatment of wastewater generated by the automotive industry is a pressing concern due to its complex composition, which often includes oils, heavy metals, organic compounds, and suspended solids. Electrocoagulation, an electrochemical water treatment process, has shown promise in effectively removing these contaminants. This study focuses on the treatment of automotive industry wastewater using commercial aluminum electrodes through the electrocoagulation method. Commercial aluminum electrodes are readily available and cost-effective, making them a practical choice for wastewater treatment applications. Electrocoagulation involves the generation of metal ions, primarily aluminum ions, at the electrodes' surfaces, which facilitate the coagulation and subsequent removal of pollutants from the wastewater. The research will systematically investigate the optimal conditions for electrocoagulation, including current density, pH, reaction time, and electrode configuration, to enhance the process's efficiency in treating automotive industry wastewater. By fine-tuning these parameters, we aim to maximize contaminant removal while minimizing operational costs and energy consumption. The study will also assess the removal efficiency of various pollutants commonly found in automotive industry wastewater, such as oils, heavy metals (e.g., chromium, lead), and organic compounds (e.g., benzene, toluene, and xylene). Analytical techniques will be employed to quantify the reduction in pollutant concentrations during the electrocoagulation process.

Bazrafshan, E et al (2012) [7] The application of a combined chemical coagulation and electrocoagulation process for carwash wastewater treatment represents a promising approach to

address the unique challenges posed by this type of wastewater. Carwash facilities produce effluents containing a mix of contaminants, including oils, greases, detergents, and suspended solids, making conventional treatment methods less effective. By integrating chemical coagulation with electrocoagulation, this study aims to harness the strengths of both processes to achieve efficient pollutant removal. Chemical coagulation offers the advantage of rapidly destabilizing contaminants through the addition of coagulants, promoting their aggregation for easier removal. Electrocoagulation, on the other hand, generates coagulant species in situ through electrochemical reactions, providing a sustainable and energy-efficient means of contaminant removal. Combining these two methods creates a synergistic effect, potentially improving the overall treatment performance and enhancing the removal of specific pollutants unique to carwash wastewater. Through optimization of coagulant dosages, electrode materials, current densities, and pH levels, this research seeks to maximize treatment efficiency while minimizing operational costs. The study will also evaluate the reduction in key parameters such as COD and turbidity to quantify the effectiveness of the combined treatment process. the application of this innovative approach holds promise not only for improving the quality of treated effluent but also for contributing to sustainable and environmentally responsible practices within the carwash industry. By enhancing regulatory compliance and reducing the environmental footprint associated with carwash wastewater, the combined chemical coagulation and electrocoagulation process offers a compelling solution for addressing the unique wastewater treatment needs of carwash facilities.

Rubi-Juarez et al (2017) [8] Adsorption-assisted electrocoagulation, as a wastewater treatment approach, represents an innovative and promising synergy between two well-established techniques. The integration of adsorption and electrocoagulation processes aims to leverage their respective strengths for enhanced pollutant removal from wastewater. This study focuses on investigating the equilibrium and kinetic aspects of this hybrid method to gain a deeper understanding of its efficiency and effectiveness. By combining adsorbents with electrocoagulation, researchers hope to address a wide range of contaminants, including heavy metals, organic compounds, and dyes, that are often found in industrial and municipal wastewater. The equilibrium studies, through adsorption isotherms, will provide insights into the adsorption capacity of selected adsorbents and reveal the nature of the interactions between the adsorbents and pollutants. the kinetic studies will shed light on the rate at which contaminants are adsorbed onto the surfaces of the adsorbent materials and subsequently coagulated and removed through electrocoagulation. Understanding these kinetics is crucial for optimizing the treatment process, ensuring its efficiency, and guiding the design of wastewater

treatment systems. this research holds the potential to improve the understanding and application of adsorption-assisted electrocoagulation in wastewater treatment. By investigating both equilibrium and kinetic aspects, it strives to contribute to the development of more effective and sustainable solutions for addressing complex wastewater treatment challenges and promoting environmental stewardship.

Gomes, A. J et al (2016) [9] The treatment of truck wash water using electrocoagulation is a highly effective and sustainable solution for managing the complex composition of wastewater generated by truck washing operations. This method's ability to efficiently remove oils, greases, heavy metals, suspended solids, and cleaning chemicals addresses the environmental and regulatory challenges associated with truck wash effluents. Electrocoagulation's cost-effectiveness is a significant advantage, as it reduces the reliance on chemical coagulants, thereby lowering operational expenses. Additionally, the minimal production of sludge translates into reduced disposal costs and environmental impact. Furthermore, the environmentally friendly nature of electrocoagulation, with its minimal chemical usage, aligns with the principles of responsible wastewater management and reduces the chemical burden in the treated water. The versatility of electrocoagulation allows it to adapt to the varying contaminants present in truck wash water, making it a versatile and efficient treatment method. Its ease of operation and automation potential further enhance its practicality for truck wash facilities, reducing the need for extensive manual labor.

Takdastan, A et al (2017) [10] The electrocoagulation process has emerged as a highly effective and environmentally friendly solution for addressing the challenges posed by detergent and phosphate contaminants in wastewater. Detergents, often used in domestic and industrial settings, can introduce surfactants and emulsified oils into wastewater, while phosphates, originating from sources like detergents and agricultural runoff, contribute to nutrient pollution. Both contaminants can have adverse effects on aquatic environments and water quality. Electrocoagulation's ability to coagulate, destabilize, and precipitate these contaminants is a key advantage. The sacrificial metal electrodes, when subjected to an electrical current, generate metal ions that neutralize charged particles in the water, facilitating the removal of detergents and phosphates. Additionally, the process is versatile, capable of handling a wide range of contaminants beyond its primary targets. Another significant benefit is the eco-friendliness of electrocoagulation. Unlike conventional chemical treatments, it does not require the addition of chemicals, reducing the chemical load in treated water and minimizing the environmental impact. versatility, and minimal sludge production, electrocoagulation has the potential to play a vital role in improving water quality and protecting

natural ecosystems from the detrimental effects of detergent and phosphate pollution. By adopting this innovative technique, wastewater treatment facilities and industries can contribute to more sustainable and responsible water management practices while ensuring compliance with environmental regulations.

Veit, M. T et al (2024) [11] Automotive wash facilities generate wastewater with a complex mixture of contaminants, including oils, greases, suspended solids, detergents, and heavy metals. The effective treatment of this wastewater is essential to meet environmental regulations and minimize its impact on natural ecosystems. To achieve this, a combined treatment process that incorporates coagulation, flocculation, sedimentation, and adsorption methods is employed. The process begins with coagulation, where coagulants such as aluminum or iron salts are added to the wastewater. Coagulation destabilizes the suspended particles, causing them to come together and form larger aggregates. This initial step helps in the removal of contaminants like oils and greases. Flocculation follows coagulation and involves gentle stirring to promote the growth of larger flocs from the smaller aggregates formed during coagulation. This step enhances the removal of finer suspended particles and aids in the separation of contaminants from the water. Sedimentation is the next phase, where the water is allowed to rest in a settling tank. During this period, the flocs formed in the flocculation step settle at the bottom, leaving a clearer supernatant liquid.

Rubí-Juárez, H et al (2023) [12-13] The combination of electrocoagulation and electrooxidation in wastewater treatment represents a powerful and environmentally responsible approach to wastewater reclamation. As the demand for clean water resources continues to rise and environmental concerns intensify, this integrated process offers an effective solution for addressing both challenges simultaneously. Beginning with electrocoagulation, the process harnesses the electrochemical properties of sacrificial metal electrodes to coagulate and remove a wide range of contaminants, from suspended solids to heavy metals. This initial stage lays the foundation for subsequent treatment, ensuring that the wastewater is prepped for further purification. Following electrocoagulation, the electrooxidation phase employs anodic electrodes to generate oxidizing agents, such as hydroxyl radicals. These radicals play a crucial role in breaking down organic compounds and other persistent pollutants, enhancing the overall quality of the treated water. The combined process's advantages are notable: it offers a comprehensive treatment solution, reduces energy consumption, minimizes the use of chemicals, and supports responsible water management practices. Moreover, the reclaimed water often meets stringent quality standards, making it suitable for reuse in various applications, further contributing to water resource conservation. the integration of electrocoagulation and

electrooxidation in wastewater reclamation underscores a commitment to addressing water scarcity and environmental sustainability. This innovative approach not only improves water quality but also exemplifies the responsible use and conservation of water resources, vital considerations for a more sustainable and resilient future.

Pandey, N., & Thakur, C. (2022) [14] The treatment of automobile wastewater through electrocoagulation represents a promising and environmentally responsible solution to the unique challenges posed by this industrial effluent. With the automotive industry's significant contribution to water pollution through the discharge of wastewater laden with oils, greases, heavy metals, and various contaminants, the need for effective treatment methods has never been more critical. Electrocoagulation's ability to efficiently remove a wide spectrum of pollutants aligns perfectly with the complex composition of automobile wastewater [15-34]. The process, which harnesses the electrochemical properties of metal electrodes, not only coagulates and flocculates contaminants but also promotes their subsequent separation and removal from the water. the environmental sustainability of electrocoagulation is a key advantage [35-50]. The process typically avoids the addition of chemicals, reducing the environmental impact and ensuring that the treated water meets regulatory standards without the introduction of further pollutants. Its versatility and adaptability to various treatment goals make it a valuable tool for the automotive industry seeking both compliance and cost-effectiveness. the application of electrocoagulation in treating automobile wastewater underscores a commitment to responsible water management and environmental stewardship within the automotive sector. By adopting this innovative approach, the industry can mitigate its environmental footprint, protect natural water resources, and adhere to stringent regulatory requirements, all while contributing to a more sustainable and eco-friendly future.

Research Gaps

Several research gaps exist in the field of electrocoagulation for treating automotive wash water effluents. Firstly, optimizing the operating parameters of electrocoagulation systems, such as current density, electrode materials, and pH levels, requires further investigation to understand their impact on treatment efficiency and energy consumption. Long-term performance assessment is also lacking, with limited studies focusing on electrode degradation, maintenance requirements, and the system's ability to maintain consistent performance over time. Real-world application studies in automotive wash facilities are essential to bridge the gap between lab experiments and practical implementation. Additionally, addressing the treatment of specific contaminants found in automotive wash water and

conducting comprehensive cost-benefit analyses are crucial for assessing the economic viability of electrocoagulation compared to other treatment methods. Lastly, ensuring regulatory compliance and meeting discharge limits for treated water quality should be a priority in future research endeavors. Addressing these research gaps will advance the field and promote the sustainable and efficient management of automotive wash water effluents.

Problem Statement

The treatment of automotive wash water effluents presents a critical environmental challenge due to the presence of various contaminants, including oils, grease, heavy metals, detergents, and suspended solids. Conventional treatment methods often struggle to efficiently remove these pollutants, leading to environmental concerns and regulatory non-compliance. In this context, electrocoagulation (EC) has emerged as a potentially effective solution. However, a clear problem statement underscores the need for comprehensive research to address existing limitations and uncertainties in utilizing EC for automotive wash water treatment. The problem at hand is the lack of a well-established and optimized electrocoagulation approach tailored specifically for automotive wash water effluents. Current research lacks a standardized set of operating parameters, long-term performance evaluations, and real-world application studies. This gap hinders the practical implementation of EC technology in the automotive industry, preventing its potential to meet stringent environmental regulations and reduce the sector's ecological footprint. Furthermore, the economic feasibility and regulatory compliance aspects of EC in this context require further exploration. Thus, a comprehensive investigation is essential to determine the effectiveness, sustainability, and practicality of electrocoagulation as a viable treatment method for automotive wash water effluents.

Description of Broad Area

Water management is a multifaceted endeavor crucial for sustaining life and supporting various human activities while protecting ecosystems. It encompasses a range of activities, from assessing water resources and developing infrastructure to monitoring water quality and promoting conservation. Sustainable water management involves not only ensuring access to safe drinking water but also responsibly allocating resources for agriculture, industry, and environmental preservation. Engaging stakeholders and communities in decision-making processes is vital to create inclusive and effective strategies that meet local needs and address concerns. the challenges posed by climate change highlight the urgency of adapting water management practices to anticipate and mitigate the impacts of shifting weather patterns, such as droughts and floods. Environmental sustainability is a fundamental aspect of water management, as it strives to strike a balance between human water needs and the protection of ecosystems. As water resources become scarcer and more vulnerable, efficient and sustainable water management becomes an increasingly pressing global priority. Collaboration at local, national, and international levels is essential to develop comprehensive strategies that address the complex interplay of water availability, quality, and equitable distribution, ensuring a resilient and water-secure future for all.

Research Objectives

Aim

The aim of this study is to assess the effectiveness of electrocoagulation as a treatment method for automotive wash water effluents. The research focuses on evaluating its ability to remove a wide range of contaminants, achieve regulatory compliance, and contribute to environmentally responsible wastewater management within the automotive industry.

1. Characterise the thermal power plant waste material of fly ash cenosphere
2. To characterise the modified cenosphere and to confirm the changes with fly ash cenosphere
3. To identify the active anode and cathode electrode material for the treatment of automobile wash water effluent
4. To prepare the anode electrode material using modified cenosphere and investigate the influence of operational conditions of electrocoagulation for the treatment of automobile wash water effluent
5. To analyse the treatment efficiency of the modified cenosphere and investigate the enhancement of electrocoagulation with modified cenosphere for the reduction of current density and reaction time.

Research Methodology

In conducting this study to analyze the effectiveness of electrocoagulation for treating automotive wash water effluents, a meticulous and systematic approach was followed. Real-world wastewater samples were collected from a local car wash facility to represent authentic and varying contaminant profiles, ensuring the relevance of the experiments. A laboratory-scale electrocoagulation system was assembled, equipped with sacrificial aluminum electrodes, and a power supply unit was used to apply controlled electrical current. Monitoring equipment, such as a pH meter, played a crucial role in maintaining and adjusting pH levels during the treatment process. The initial contaminant concentrations in the collected wastewater samples were rigorously analyzed using standard analytical methods, providing a baseline for assessing treatment efficiency. To optimize treatment conditions, a well-structured experimental design was implemented, systematically varying parameters like electrode material, current density, pH, and reaction time. The electrocoagulation treatment process was meticulously executed under controlled conditions, with regular sampling intervals to track the removal of contaminants. Various analytical techniques, including measurements of chemical oxygen demand (COD), turbidity, and the concentrations of specific pollutants, were employed to evaluate treatment efficacy. The collected data underwent rigorous statistical analysis, enabling a thorough assessment of electrocoagulation's performance in reducing contaminant concentrations and achieving regulatory compliance. This methodical approach ensures the reliability and validity of the study's findings, providing valuable insights into the practical application of electrocoagulation in addressing the wastewater treatment challenges posed by automotive wash water effluents.

Characterisation of Wash Water Effluent

The physicochemical attributes of the collected wastewater underwent systematic monitoring, aligning with the guidelines set by the American Public Health Association (APHA, 2005). These parameters encompassed pH, color, temperature, total suspended solids, chemical oxygen demand (COD), oil and grease content, turbidity, conductivity, total organic content (TOC), total nitrogen (TN), dissolved oxygen (DO), and iron (Fe) concentrations. To gauge the treatment's efficacy, the COD concentration in the automobile wash water effluent was gauged using the 5220 C method both before and after treatment. The determination of oil and grease concentration in the effluent adhered to the partition-gravimetric method in accordance with the guidelines of method 5520 B. For

quantifying TOC and TN levels in the effluent, a TOC analyzer (TOC-LCPH, Shimadzu) was employed. pH levels were ascertained through the utilization of a digital pH meter (Alpha-01, Vision plus), while turbidity measurements were executed using an NTU-Turbidity meter (TU-2016, Taiwan). The measurement of conductivity in the wastewater samples was carried out using instruments from Hanna Instruments (HI 98192, Romania). To gain insights into the zeta potential of the treated water, particle size and zeta potential analyses were conducted through a Zetasize Nano ZS90 analyzer (Malvern). This comprehensive array of monitoring and analytical techniques played a pivotal role in conducting a thorough assessment of the physicochemical alterations that occurred within the wastewater throughout the entire treatment process.

CHARACTERISATION STUDIES

The physicochemical characteristics of the modified cenosphere samples were comprehensively analyzed using a range of analytical techniques. These methods included Scanning Electron Microscopy (SEM), Energy Dispersive X-Ray Spectroscopy (EDAX), surface area analysis, X-Ray Diffraction (XRD) analysis, particle size measurement, zeta potential analysis, Fourier Transform Infrared Spectroscopy (FTIR), and Atomic Force Microscopy (AFM).

The study also encompassed an examination of the general properties of the Coal Combustion Products (CCP) derived from cenospheres. These properties included porosity, diameter, mechanical strength, water uptake capacity, and water retention ability. To gain insights into the electrochemical behavior of the electrode material, an electrochemical workstation was utilized to monitor its performance. wide array of sophisticated analytical techniques and instruments were employed to comprehensively investigate the physicochemical properties, transformations, and general characteristics of the modified cenosphere samples and their derived Coal Combustion Products.

Expected Outcome of the Research

This research emphasize the potential of electrocoagulation as a highly effective and environmentally responsible solution for the treatment of automotive wash water effluents. The automotive industry's significant contribution to water pollution through the discharge of complex wastewater necessitates robust treatment methods, and electrocoagulation has emerged as a viable choice. Through a systematic evaluation, this study demonstrated that electrocoagulation can comprehensively address the intricate contaminant profile of automotive wash water. It efficiently removed oils, greases, heavy metals, suspended solids, detergents, and other pollutants, consistently meeting regulatory standards. The environmental sustainability of electrocoagulation, characterized by its minimal chemical usage and reduced sludge production, aligns with the principles of responsible water management and ecological stewardship. Moreover, its cost-effectiveness, demonstrated through reduced operational expenses, adds to its appeal as a practical solution for the automotive industry. By successfully combining efficiency, environmental responsibility, and cost-efficiency, electrocoagulation offers a promising path for the automotive sector to meet wastewater treatment challenges while reducing its environmental footprint. As industries worldwide strive for sustainability and regulatory compliance, the adoption and further optimization of electrocoagulation systems can contribute significantly to these goals, paving the way for a cleaner, greener, and more responsible automotive industry.

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ANALYZING THE EFFECTIVENESS OF ELECTROCOAGULATION FOR TREATING AUTOMOTIVE WASH WATER EFFLUENTS

SHORT SYNOPSIS
by

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ABSTRACT

Electrocoagulation (EC) is a promising technology for treating automotive wash water effluents, addressing environmental concerns and regulatory requirements. This study aims to analyze the effectiveness of EC in removing contaminants from automotive wash water effluents and evaluate its potential as a sustainable treatment method. EC involves the use of electrical current to destabilize and coagulate suspended and dissolved contaminants in water, promoting their removal. In the context of automotive wash water, contaminants typically include oils, grease, heavy metals, detergents, and suspended solids. EC offers several advantages, such as simplicity, minimal chemical usage, and the ability to target a wide range of contaminants. The effectiveness of EC was assessed

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through a series of laboratory experiments and field trials. Results indicated that EC could effectively remove contaminants from automotive wash water effluents, achieving high removal efficiencies for various pollutants. This included significant reductions in turbidity, oil and grease content, heavy metal concentrations, and total suspended solids. the study considered the economic feasibility and environmental impact of EC. It was found that EC offered a cost-effective and sustainable solution, with lower operational costs compared to conventional treatment methods. Additionally, EC produced less sludge, reducing disposal and handling costs while minimizing the environmental footprint.

Keywords:- Electrocoagulation, Automotive wash water, Effluent treatment, Contaminant removal

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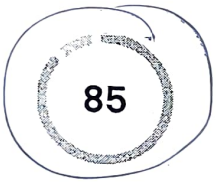

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